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Research article

Tales of transforming cities: Transformative climate governance capacities in New York City, U.S. and Rotterdam, Netherlands

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ABSTRACT

Climate change actions in cities worldwide are driving deep changes in urban governance. We ask whether new capacities for transformative climate governance are emerging in two cities that have experimented with urban climate governance: Rotterdam, the Netherlands, and New York City (NYC), United States. Transformative climate governance creates the conditions for developing integrated and innovative climate mitigation and adaptation policies and interventions that respond to and shape urban transformation dynamics and contribute to sustainability and resilience. The comparison of capacities for transformative climate governance in Rotterdam and NYC offers insights into the emerging features of urban climate governance vis-à-vis existing urban governance regimes: how urban climate governance is driven and delivered, what new governance conditions emerge, and whether these conditions enable transformative climate governance. In both cities, an integrated, experimental and inclusive approach to climate governance is emerging, which crosses multiple policy sectors and domains (e.g. transport, energy, health, justice), involves a variety of actors and facilitates innovative solutions. Envisioning, long-term goal and knowledge integration, experimentation and tapping into coalitions for change help to provide the basis (including guiding principles, urgency, actor networks, innovative solutions) for transformative climate governance. However, these transformative approaches tend to be still subordinate to business-as-usual interests and policy and planning approaches, which favour isolated, incremental and short-term responses. The challenge for strengthening transformative climate governance will be to develop rigorous institutional and organisational conditions that decisively stipulate a prioritisation of climate change across scales and sectors, provide action mandates and enable wider coordination, collaboration and learning.

1. Introduction

In the last decade, climate action in cities has become formally recognised as a vital part of the global response to climate change and pressing sustainability challenges (Amundsen et al., 2018; van den Heijden, 2018). What is common across the burgeoning activities to govern climate change in cities worldwide is that they are driving deep changes in urban governance towards more integrated, experimental and inclusive approaches (Castán Broto, 2017; Romero-Lankao et al., 2018a; Bulkeley and Betsill, 2013). In an effort to integrate climate change into urban decision-making and planning processes, local governments have framed climate mitigation and adaptation as opportunities for enhancing liveability and wellbeing in cities (Shaw et al., 2014; Aylett, 2015; den Exter et al., 2014). Urban climate experimentation has been a central means for trialling and de-risking innovative and agile sustainable solutions (Castán Broto and Bulkeley, 2013; Evans et al., 2016). The premise is that experimentation facilitates collaborative learning processes between multiple actors, dealing with significant uncertainties and complexities of climate change and radical innovation (Bulkeley et al., 2016; Karvonen, 2018). While local governments have taken a leading role in urban climate governance, a plethora of actors from local communities, regional and national governments, businesses and research institutes contribute to delivering climate action by generating and integrating knowledge, experimenting

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with social, economic and technological innovations and self-organising service provisions (Bulkeley, 2010; Burch et al., 2016; Moloney and Horne, 2015; Hughes et al., 2017).

In this paper, we ask whether climate governance efforts in cities have created new capacities for transformative climate governance. We employ transformative climate governance to position urban climate governance as part of the quest for urban transformations towards sustainability and resilience. This means that climate mitigation and adaptation are not any more isolated objectives, but integrated within the need for radical and structural changes in urban systems to create and maintain environmental integrity, social equity, human well-being and economic feasibility in the long-term (cf. Pickett et al., 2013; McCormick et al. 2013). Transformative climate governance implies a fundamental change of urban governance systems to take more seriously the complex, uncertain and contested dynamics of urban transformations under climate change that unfold across scales and sectors (Loorbach et al., 2015; Romero-Lankao et al., 2018a; Alberti et al., 2018). Due to the complex interactions between climate change and urban systems, sectoral and add-on approaches to addressing climate change that primarily serve to mitigate the negative externalities of other policy areas are unable to create stepping stones for overcoming the structural root causes of excessive greenhouse gas emissions and vulnerability to climate-related impacts (Shaw et al., 2014; Burch et al., 2018).

To date, even in cities that are leading with ambitious climate agendas climate policy and planning initiatives often remain add-on priorities to short-term and optimisation-focused mainstream policy and planning practices (Anguelovski and Carmin, 2011; Aylett, 2015). As a result, action for climate change frequently draws the short straw when competing with 'pressing' urban needs and it relies on easy investments in low-hanging fruits that do not fundamentally question existing behaviours and interests (Ürge-Vorsatz et al., 2018; Gouldson et al., 2015). Climate mitigation and adaptation are often developed in incremental, reactive and technocratic ways, which perpetuate maladaptation (Moloney and Horne, 2015; Torabi et al., 2018). For example, many climate adaptation measures are technological interventions to reduce hazard exposure and vulnerability of buildings and infrastructures without accounting for the social, cultural, economic, political and institutional characteristics of cities (Nordgren et al., 2016). Such measures fail to address issues related to the long-term uncertainties as well as unequal burdens of climate impacts (Torabi et al., 2018; Reckien et al. 2017).

We compare climate governance activities in Rotterdam, the Netherlands, and New York City (NYC), United States, and assess whether these have resulted in new capacities for transformative climate governance. Rotterdam and NYC are examples of cities providing global leadership and setting a standard for climate change adaptation and mitigation with ambitious and cross-cutting climate, sustainability and resilience agendas and a portfolio of innovative solutions for climate mitigation and adaptation (Solecki et al., 2016; Forgione et al., 2016; McPhearson et al., 2014; Ernst et al., 2016; Frantzeskaki and Tillie, 2014; Depietri and McPhearson, 2018; McPhearson and Wijsman 2017). The comparison of governance capacities in both cities offers insights into the emerging features of urban climate governance vis-à-vis existing urban governance regimes, including how and by whom urban climate governance is driven and constrained, what governance conditions emerge as a result, and whether these conditions indeed enable transformative climate governance.

2. Conceptual framework: capacities for transformative climate governance

This section first defines transformative climate governance in cities and then presents our conceptual framework of capacities for transformative climate governance. The term 'governance' recognises that diverse types of actors (e.g. from civil society, economy, government, research) participate in the intentional coordination of social actions through hybrid forms of partnerships and networks (Kooiman, 1993; Jessop, 1997). The lens of governance capacities helps understanding how, and by whom, urban climate governance is enacted, what conditions emerge as a result, whether these conditions mark a shift towards transformative climate governance, and what are capacity gaps.

The conceptual framework draws on work related to urban climate governance that has converged within the loosely connected field of urban transformation research (Wolfram et al., 2017). Urban transformation research has been driven by the recognition that radical societal change is needed to achieve sustainable and resilient urban systems (Wolfram et al., 2017). It includes urban sustainability transitions approaches that address questions related to the critical enablers and barriers to innovations in climate solutions and governance (Burch et al. 2014; Brown et al., 2013) as well as what type of governance facilitates low-carbon transitions and climate adaptation (Nevens et al., 2013; Hodson and Marvin, 2010; Loorbach et al., 2015; Frantzeskaki et al., 2018). Urban climate adaptation and resilience literatures highlight the need for flexible and decentralised governance institutions and social networks that enable learning, self-organisation and fit-to-context management approaches in the face of long-term and uncertain risks (Boyd et al., 2014; Torabi et al., 2018).

2.1. Transformative climate governance in cities

Transformative climate governance starts from the premise that climate change cannot be anymore addressed as an isolated problem in cities. Rather, a view of climate change as a symptom, and amplifier, of unsustainable path-dependencies and mal-adaptation in urban planning makes clear that climate mitigation and adaptation should be part of the quest for transformations to sustainability and resilience (Romero-Lankao et al., 2018a; Burch et al., 2018). This is what we term *transformative* climate governance: transformative climate governance develops problem-based and systemic climate mitigation and adaptation policies and interventions that contribute to and maintain environmental integrity, social equity and well-being and economic feasibility (sustainability) under complex, contested and uncertain transformation dynamics (resilience) (cf. Hölscher et al., 2018a; Pickett et al., 2013; Meerow et al., 2016).

On the one hand, embedding governance activities to address climate change within the endeavour to steer urban sustainability and resilience transformations opens up opportunities for systemic climate solutions that also enhance the quality of life, ensure social equity and help avoid locking a city into counterproductive infrastructures and policies (Romero-Lankao et al., 2018a; McPhearson et al., 2016a, 2016b; Burch et al., 2018). This draws attention to the social and economic root causes driving high-emission trajectories and vulnerabilities to climate change in cities, including individual values and behaviours, built urban structures, political conflicts and economic opportunities (Ürge-Vorsatz et al., 2018; Rosenzweig et al., 2015; Burch et al., 2018).

On the other hand, addressing climate change in the context of urban transformations reveals the systemic, complex, uncertain, contested and long-term characteristics of climate change (Romero-Lankao et al., 2018b; McCormick et al. 2013). Transformation dynamics are visible in institutional, technological and behavioural path-dependencies and lock-ins, which perpetuate high-emission trajectories and mal-adaptation (Ürge-Vorsatz et al., 2018; Seto et al., 2016). They also become visible in the uncertainty of future climate impacts and how they affect urban systems (Carter et al., 2015; Rosenzweig et al., 2015). This requires long-term governance approaches that give special attention to learning, participation, knowledge co-production, long-term thinking, experimentation and flexibility (Wolfram and Frantzeskaki, 2016; Wittmayer et al., 2018).

In summary, our definition of transformative climate governance in cities responds to three questions: Transformative climate governance

Table 1
Tenets for transformative climate governance in cities.

Characteristics of climate change as urban transformation challenge	Tenets for transformative climate governance in cities
Systemic: cross-scale, cross-sectoral and long-term drivers and impacts ● Climate change is propelled by and affects multiple urban systems (e.g. economy, agriculture, water, health, transport) and systems' dimensions (e.g. urban land-use, infrastructures, lifestyles (Rosenzweig et al., 2015; Seto et al., 2017; Ürge-Vorsatz et al., 2018). ● Drivers and impacts are cross-sectoral and cross-scale; e.g. they interact with diverse processes (e.g. wetland loss, ageing infrastructure, coastal development vulnerabilities) (Alberti et al., 2018). ● Long periods of time pass between the emission of GHGs and the impacts of a changing climate (Meadowcroft, 2009).	**Problem-based system perspective: climate governance of what?** Develop fit-to-context and fit-to-purpose climate strategies and actions that address the social, economic, institutional, technological, political and economic root causes driving high emissions, mal-adaptation and vulnerabilities to climate change impacts in the long-term and across scales and sectors (Ürge-Vorsatz et al., 2018; Wittmayer et al., 2018; Runhaar et al., 2018; Romero-Lankao et al., 2018b).
Co-evolution: build-up and break-down patterns involving path-dependency, uncertainty and thresholds ● Mutually reinforcing physical, economic and social constraints (e.g. long infrastructure lifetimes, institutions, behaviours, large capital costs) constrain the rate and magnitude of emissions reductions and climate adaptation in cities (Seto et al., 2017; Rosenzweig et al., 2015). ● A lot of uncertainties girdle climate impacts, e.g. concerning the sensitivity of the climate system (how much warming will result from a certain increase of GHG concentrations), regional climate impacts and consequences for ecosystems (Meadowcroft, 2009; Carter et al., 2015). ● These climate-related uncertainties are exacerbated by the likelihood of surprises and unexpected shocks – as illustrated by Hurricanes Sandy and Katrina – which can lead to radical discontinuities (Alberti et al., 2018).	**Mobilising transformation dynamics in tune with opportunity contexts: climate governance processes** Mobilise and respond to different types of transformation dynamics by facilitating disruptive innovation, destabilising unsustainable regimes (Bosman et al., 2018; Ürge-Vorsatz et al., 2018; Loorbach et al., 2015) and safeguarding from disturbances, risks and uncertainty (Rosenzweig et al., 2015; Torabi et al., 2018). This requires staying tuned to opportunity contexts to make use of crisis as opportunities for overcoming system inertia while ensuring effective coping and incremental responses that contribute to radical change in the long-term.
Sustainability and resilience: normativity, trade-offs and contestation While responsibilities for climate change are unequally distributed, climate change will impact vary across different geographical locations and different groups (Castán Broto, 2017; Reckien et al. 2017; Romero-Lankao et al., 2018b).	**Co-creating integrated climate, sustainability and resilience goals: climate governance for what and for whom?** Ensure co-creative and inclusive decision-making processes to position climate mitigation and adaptation within sustainability and resilience goals, foster social justice and provide a broad variety of approaches and solutions building on discussions about the allocation of responsibilities and duties among diverse public and private actors (Tanner et al., 2009; Wittmayer et al., 2018). Sustainability is a socially negotiated, normative set of goals for achieving environmental integrity, social equity, human well-being and economic feasibility now and in the future (Pickett et al., 2013). Resilience indicates the properties and interactions determining whether urban systems can adapt and transform in response to disturbances and uncertainty in the short- and mid-term and shape change in the long-term (Pickett et al., 2013; Meerow et al., 2016).

develops problem-based and systemic climate mitigation and adaptation policies (*governance of what?*) that contribute to sustainability and resilience across sectors and scales (*governance for what and whom?*) by creating the conditions for mobilising and responding to different types of transformation dynamics (*climate governance processes*) (Table 1).

2.2. Capacities for transformative climate governance

Transformative climate governance is transformative of urban governance systems themselves, by postulating new types of conditions for integrated, innovative, flexible and inclusive approaches to addressing climate change, sustainability and resilience. We developed a framework of capacities for transformative climate governance that helps explaining and evaluating what types of governance conditions are created by urban climate governance activities, and whether these conditions contribute to transformative climate governance (cf. Hölscher et al., 2018a).

The perspective on governance capacity helps bridging between the diverse actors and activities engaged in urban climate governance and the conditions that (need to) emerge as a result by connecting actors ('who'), context and strategies ('how'), and outcomes ('what') (Fig. 1). It views governance as a structuration process: According to structuration theory actors are both enabled and constrained in their actions by the structural frameworks in which they operate (Giddens, 1979). However, actors are also able to adapt to and change their structural contexts (Giddens, 1979; Garud et al. 2007). Accordingly, while multiple actors perform acts of governing by making purposive decisions, deliberate actions and strategic choices, their actions and interactions are shaped by institutionalised working arrangements (e.g. organisational settings, rules, regulations) and broader socio-economic and political contexts (e.g. political commitment, available resources) (Hodson et al., 2018; Koop et al., 2017). Governance capacities are thus manifest in the activities through which actors deliberate between contested solutions (rather than promoting individual actor interests) and navigate their structural contexts, which also change as a result of actors' interventions (Koop et al., 2017; Bettini et al., 2015). Governance capacities are mobile: they are continuously developed and adapted through the actions of diverse governance actors.

As shown in Fig. 1, the framework distinguishes between four critical capacities. Each capacity manifests in different types conditions that are created by actors' activities and that enable delivering distinct output functions for transformative climate governance. Together, the capacities enable transformative climate governance: they enable mobilising urban transformation dynamics and develop integrated and systemic climate mitigation and adaptation actions that contribute to sustainability and resilience. Supplementary Material A provides a comprehensive overview of the operationalisation of the capacities with the supporting sources (Hölscher et al., 2018a).

2.2.1. Stewarding capacity

Climate impacts and vulnerabilities cause short-term and long-term risks, uncertainty and surprise in cities (Johnson et al., 2015; Rosenzweig et al., 2015; Carter et al., 2015). Stewarding capacity enables anticipation of and responsiveness to uncertainty and risk while exploiting opportunities beneficial for sustainability. Stewarding capacity is manifest in conditions that enable learning and flexible responses to (uncertain) change and disturbance. The generation of knowledge about complex, long-term social-ecological system dynamics across scales enables the anticipation of emergent risks and uncertainties (Koop et al., 2017; McPhearson et al., 2015; Chelleri et al., 2015).

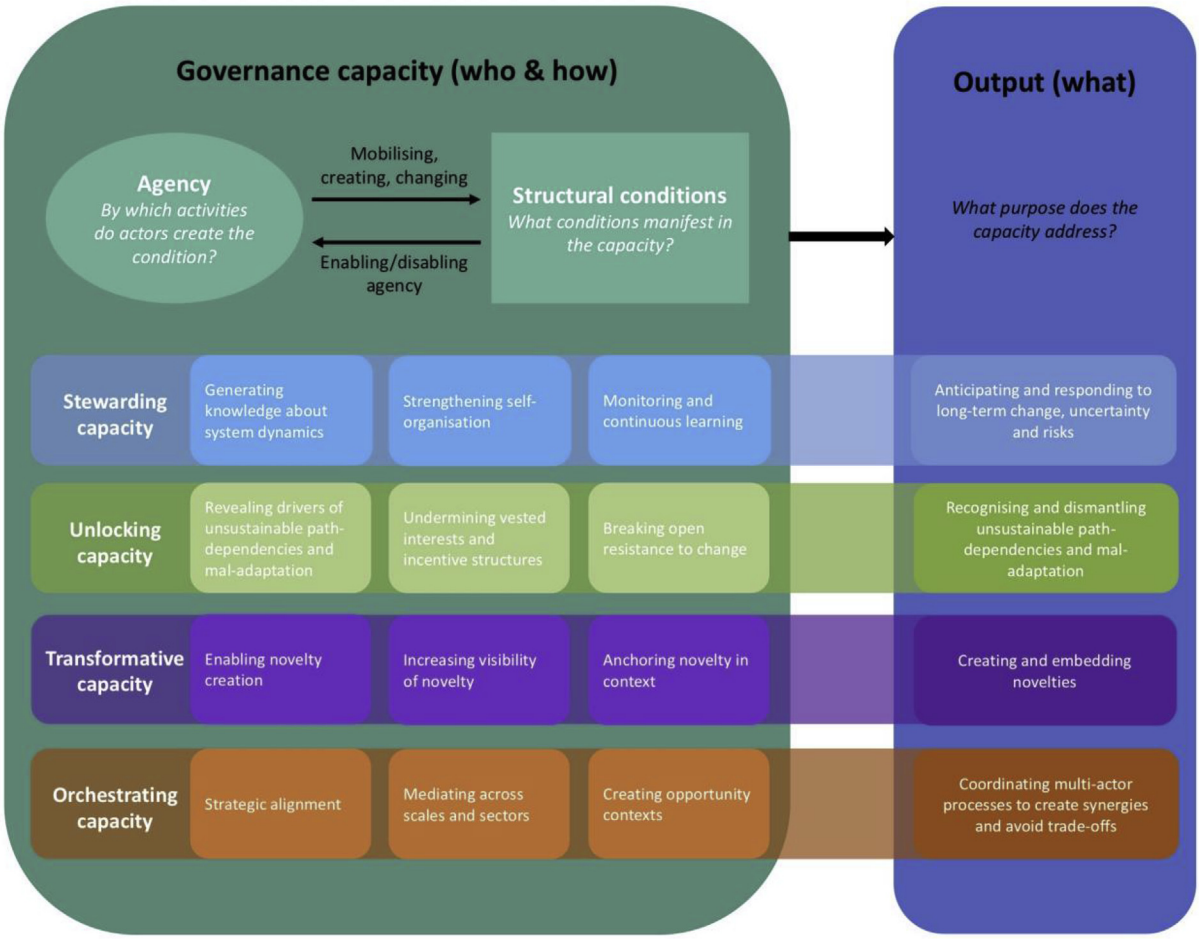

Fig. 1. Conceptual framework: capacities for transformative climate governance.

Decentralised, fit-for-context and flexible institutions and networks that incorporate long-term risks facilitate dynamic responses to changes and disturbances (Torabi et al., 2018; Tanner et al., 2009; Boyd et al., 2014). Monitoring and participatory learning are key ingredients to adapt management objectives and practices to changing situations in line with new information (Tanner et al., 2009; Koop et al., 2017).

2.2.2. *Unlocking capacity*

Dominant urban land-use, design and living patterns that drive current high emission and unsustainable urban development pathways are deeply embedded in existing institutions, technologies, actor networks, behaviours and values (Bai et al., 2017; Ürge-Vorsatz et al., 2018; Seto et al., 2016; Bosman et al., 2018). Unlocking capacity is manifest in the abilities of actors and the conditions that enable recognising and dismantling of the structural drivers of unsustainable path-dependencies and mal-adaptation. Knowledge generation mechanisms like baseline measurements and system analyses help to recognise institutions, technologies and behaviours that perpetuate mal-adaptation and need to be strategically phased out (Sperling and Ramaswami, 2017; Loorbach et al., 2015; Jhagroe and Frantzeskaki, 2015). Undermining vested interests, existing (financial, regulatory) incentive structures and actor networks serves to reduce the comparative advantage of business-as-usual and developing economically attractive business cases (Sperling and Ramaswami, 2017; Gouldson et al., 2015; Kivimaa and Kern, 2016; Seto et al., 2016). Breaking open resistance to change diminishes support for business-as-usual and creates opportunities and awareness for alternatives (Bettini et al., 2015; Sperling and Ramaswami, 2017; Moloney and Horne, 2015; Meadowcroft, 2009).

2.2.3. *Transformative capacity*

Escaping current unsustainable and mal-adaptive urban development trajectories requires the development and diffusion of radical alternatives that provide new ways of doing, thinking and organising (Brown et al., 2013; Frantzeskaki et al., 2017; Loorbach et al., 2015). Transformative capacity enables creating novelties that contribute to sustainability and resilience and the embedding of these novelties in structures, practices and discourses. The condition for novelty creation ensures space, resources and networks for developing and testing innovations (Raven et al., 2010; Loorbach et al., 2015; Nevens et al., 2013; McPhearson et al., 2017). To challenge dominant regimes and motivate acceptance and update, innovation needs to gain traction and support, which is facilitated by the condition to increase the visibility of novelty (Nevens et al., 2013; Frantzeskaki et al., 2017; Brown et al., 2013). Anchoring the novelty in context ensures its replication, scaling and mainstreaming by routinizing and institutionalising the innovation in organisational, institutional and operational structures and processes (Ehnert et al., 2018; Den Exter et al., 2014; Wamsler, 2015).

2.2.4. *Orchestrating capacity*

The distributed nature of urban climate governance activities across governance networks, scales and sectors induces a need for encouraging, coordinating and assisting action in alignment with shared long-term goals (Pahl-Wostl and Knieper, 2014; Hodson and Marvin, 2010; Keskitalo et al., 2016). Orchestrating capacity is manifest in the abilities of actors to coordinate multi-actor urban governance processes and foster synergies and minimise trade-offs and conflicts across scales, sectors and time. Strategic alignment supports the formulation of shared, integrated and long-term goals towards which climate actions

Fig. 2. Floating Pavilion and trees for climate adaptation in Rotterdam (source: Gemeente Rotterdam 2018).

are oriented (Hodson and Marvin, 2010; Moloney and Horne, 2015; Chu et al., 2017; McPhearson et al., 2017). Mediating across scales and sectors through formal and informal structures, spaces and communication channels enables knowledge and resource sharing and conflict resolutions (Hodson and Marvin, 2010; Kivimaa, 2014). The creation of opportunity contexts establishes framework conditions for clarifying costs, benefits and responsibilities and incentivising and assisting actions towards long-term goals (Pahl-Wostl and Knieper, 2014; Fidelman et al., 2013).

3. Materials and method

We conducted a qualitative comparative case study to compare climate governance activities in Rotterdam and NYC and whether these have resulted in new types of capacities for transformative climate governance. The comparison of governance activities and resulting capacity conditions in Rotterdam and NYC enables interpreting similarities, differences and patterns manifest in capacities for transformative climate governance in different urban contexts (Eisenhardt and Graebner, 2007). Details on data collection and analysis will follow an introduction to the case study contexts.

3.1. Learning from Rotterdam and New York City

Rotterdam and NYC are examples of cities where local governments have pioneered integrated and ambitious strategies and innovative solutions for addressing climate change, sustainability and resilience. Both cities are members of Connecting Delta Cities and 100 Resilient Cities, and other international city networks used to exchange knowledge and promote inter-city learning. Our case selection builds on the assumption that in both cities new types of governance capacities have already been built. The cities therefore offer ample opportunities to learn about activities and conditions for transformative climate governance, as well as how they can be strengthened.

Rotterdam and NYC are both delta cities, mark important economic centres in their region and face a diversity of climate change impacts and broader socio-economic challenges. Rotterdam is located in the South-West of the Netherlands, has a population of over 650.000 inhabitants and hosts the largest ports in Europe. NYC is located at the east coast of the US and accommodates an estimated population of over 8.55 Million people (US Census Bureau, 2015). Expected climate impacts in Rotterdam and NYC include sea level rise, rising river and groundwater levels, increasing severity of heavy downpours and storms, coastal and storm surges and heat waves (Molenaar et al., 2013; NPCC, 2015). Both cities have already experienced climate extremes that highlighted numerous risks for the cities' populations and infrastructure. In NYC, Hurricane Sandy's landfall in October 2012 has been a hallmark that exemplified the city's climate resilience challenges (NYC, 2013; Depietri and McPhearson, 2018; McPhearson et al., 2014).

In Rotterdam, climate change was introduced in the city government's agenda in 2007 with the Mayor's goal to reduce CO_2-emissions by 50% in 2025 compared to 1990 and the launch of the Rotterdam Climate Initiative (RCI). Concomitantly, water policy entrepreneurs formulated the goal to become climate-proof by 2025. This involved reframing the perception of water as a threat towards recognising climate adaptation as opportunity for improving the city's social and economic attractiveness (RCI, 2009; De Greef, 2005; Van der Brugge and de Graaf, 2010). Until today, the climate change focus was successively expanded towards sustainability, liveability and, most recently, resilience (Gemeente Rotterdam, 2012, 2015, 2016). However, the official CO_2-reduction target was removed for political reasons. This strategic approach was institutionalised in the city government's cross-cutting Sustainability and Climate Adaptation Offices that coordinate climate, resilience and sustainability-related actions and collaborate with other city departments, levels of government (e.g. national government, water boards (regional government bodies charged with managing water barriers, waterways, water quality) and private actors. The city gained international recognition particularly through its high-profile proof-of-concept experiments that deliver co-benefits for climate adaptation, greening, recreation, community-building and economic development. Examples include the Benthemplein water square, which combines rainwater management with area development, the multi-functional underground water storage facility at Museumplein car park and the Floating Pavilion in the City Ports area (Fig. 2).

In NYC, Mayor Bloomberg (2002–2014) ignited the city-wide agenda on sustainability and climate mitigation by commissioning a cross-cutting sustainability and climate mitigation plan. Released in 2007, PlaNYC tied goals such as emissions reductions, improving air quality, managing population growth, modernising infrastructure and the city's long-term liveability and global competitiveness (NYC, 2007). Following Hurricane Sandy in late 2012, the Special Initiative for Rebuilding and Resiliency (SIRR) was convened to develop a programme

for reducing the city's vulnerability to coastal flooding and storm surge and for rebuilding communities (NYC, 2013). When Mayor de Blasio took office in 2014, he issued 'One New York: The Plan for a Strong and Just City' (OneNYC) (NYC, 2015a), introducing affordable housing and social equity as top priorities for resilience and sustainability. The cross-departmental Mayor's Offices of Sustainability (MOS) and Recovery and Resiliency (ORR) were established to spearhead the city government's efforts on climate change, resilience and sustainability. MOS, ORR and city departments closely work together with business networks, community organisations and they participate in cross-sectoral and cross-scale knowledge platforms and partnerships. These efforts resulted in diverse measures, including green infrastructure projects, regulations (e.g. on energy efficiency in buildings) and community resilience building. For example, the NYC Cool Neighbourhoods programme was launched in 2017 to protect citizens from extreme heat by combining green infrastructure, health training and supporting low-income households (NYC, 2017). The Federal Department of Housing and Urban Development (HUD) initiated the Rebuild-by-Design (RbD) competition to develop and implement innovative projects for re-building, community resilience and sustainability in the Sandy-affected region. This is resulted in three innovative projects located in NYC: The BIG U integrates green infrastructure and liveability for flood protection in Lower Manhattan, the Living Breakwaters project envisions living reefs along Staten Island's south shore to accommodate flooding (Fig. 3), and the Hunts Point Lifelines project in the Bronx integrates flood protection, recreation, health, local livelihood development and emergency management (RbD, 2016; Grannis et al., 2016).

3.2. Data collection and analysis

We performed desktop research to review policy documents (strategies, visions and programmes from 2007 to 2017, including Gemeente Rotterdam, 2015, 2016; RCI, 2012 for Rotterdam and NYC, 2007; 2010, 2015a,b for NYC), media articles and scientific papers about climate, resilience and sustainability governance in Rotterdam and NYC. Secondly, we conducted semi-structured interviews with a mix of informants from local, regional (in Rotterdam referring to water boards, in NYC from the New York State government), national governance scales as well as from government, market and civil society that are involved in climate governance in the context of the respective city (Table 2). We attended workshops and meetings related to strategy formulation and knowledge exchange. In Rotterdam, two of the authors were involved in different vision and strategy development processes in Rotterdam city between 2012 and 2016, including the re-development of the City Ports area (Frantzeskaki et al., 2014) and the formulation of the resilience strategy (Gemeente Rotterdam, 2016; Lodder et al., 2016). One author has been a member of the NYC ORR's Urban Heat Island Task Force, advises on research and implementation for multiple city agencies, and co-leads the integrated NYC Stormwater Resiliency research together with ORR and NYC Department of Environmental Protection (DEP) to deliver recommendations for significant city investments to enable short- and long-term flood resiliency.

Table 2
Interviews conducted for the case studies.

	Interviews in total	Interviewees according to sector	Period interviews were conducted
Rotterdam	28	Local city government (11) Regional government (1) National government (1) Knowledge institutes (4) Local businesses and architects (6) NGOs and community-based organisations (3) Politicians (2)	03–06/2015
NYC	38	Local city government (12) Regional government (4) National government (2) Knowledge institutes (7) Local businesses, architects and business platforms (6) NGOs and community-based organisations (7)	10/2015–01/2016

For each case study, the collected data was analysed in reference to the capacities framework (see also Hölscher et al., 2018a). Firstly, we analysed how the capacity output functions stewarding, unlocking, transforming and orchestrating are addressed in climate-related policy and planning practice in Rotterdam and NYC. Secondly, for each capacity we analysed the activities by which multiple actors develop and implement climate-related action and whether the activities manifest in new types of governance conditions. This step involved theory-driven coding of the collected data to relate the activities to the capacity conditions of the framework (Saldana, 2009; see Supplementary Material B). Thirdly, we identified challenges that reflect capacity gaps

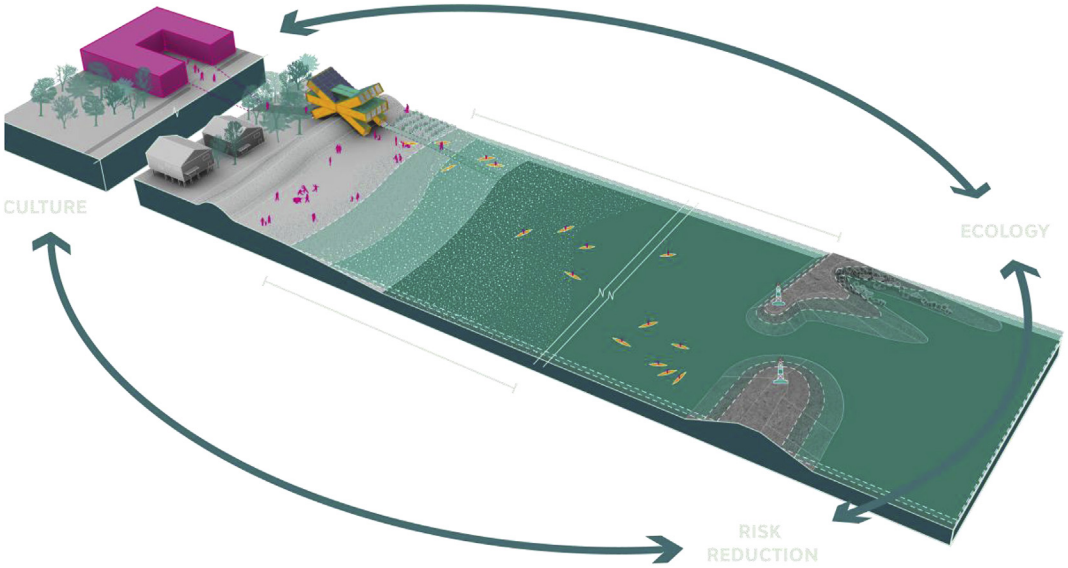

Fig. 3. The Living Breakwater Project envisions living reefs along Staten Island's south shore to accommodate flooding, protect ecology and strengthen local communities. This is a concept image that was developed for the Rebuild by Design competition (source: SCAPE Team for the Rebuild by Design Competition 2015).

for fulfilling the functions.

This paper presents the findings from our comparative analysis of the governance capacities in Rotterdam and NYC to identify similarities, differences and patterns in what types of conditions were created, how and by whom they were created and how the functions were fulfilled (Eisenhardt and Graebner, 2007).

4. Results: capacities for transformative climate governance in Rotterdam and NYC

The activities and processes to govern climate change in Rotterdam and NYC manifest in new conditions for stewarding, unlocking, transformative and orchestrating capacity. These help to address climate mitigation and adaptation in integrated, inclusive and experimental ways to facilitate responding to uncertainty and risk, phasing out drivers of unsustainable path-dependency and mal-adaptation, create social, technological and institutional innovations and coordinate multi-actor processes across scales and sectors. Supplementary Material B includes a full overview of conditions and activities with examples and illustrations from both cities.

4.1. Stewarding capacity in Rotterdam and NYC

Stewarding capacity influences which and how disturbances are anticipated and what responses are enabled. In both cities, conditions for stewarding have been created by developing a vast amount of knowledge on systemic risks and uncertainties relating to flooding, storms and health, establishing integrated, long-term and multi-level planning approaches and supporting diverse social networks. While Rotterdam and the Netherlands have a long-standing policy tradition on ensuring water safety, which is reflected in the high levels of infrastructure protection in Rotterdam, NYC combines long-term infrastructure protection with community resilience and providing short-term emergency relief.

In both cities, a thorough knowledge base was created about short-term and long-term climate impacts and related social-ecological risks and vulnerabilities. Knowledge includes projections of long-term sea-level rise and flood safety risks, heat and health stresses and infrastructure risks (RCI, 2012; NPCC, 2015). Informants have highlighted the critical role of knowledge programmes in bringing together actors from local, regional and national governments, academia, businesses and local communities to generate issue-specific knowledge at different scales (e.g. regional, communities). In the Netherlands, the Dutch government initiated multi-actor research programmes like Knowledge for Climate to generate knowledge on climate impacts in high-impact regions in the Netherlands, including Rotterdam (Van den Berg et al., 2013; Van Veelen, 2013). Mayor Bloomberg set up the NYC Panel on Climate Change (NPCC) to report on climate risks and adaptation needs (NPCC, 2015). NYC city departments including Emergency Management (EMD), Parks and Recreation (DPR) and the Health Department contribute to creating knowledge on emergency planning, coastal resilience and ecosystem services (NYC, 2015b; Forgione et al., 2016). In both cities, informants also highlighted the creation of knowledge mandates about risks. For example, the province of South-Holland asks municipalities to make risk assessments for inhabitants of outer-dike areas.

The systemic, long-term and context-specific perspective on risks, vulnerabilities and uncertainty was integrated in planning and management approaches. The NYC government revised hurricane evacuation zones, placing a greater focus on the varying angles of approach for different storms, and employs regulatory instruments, including building codes and zoning, to ensure that building and area developments take future climate impacts into account. Planning and management approaches are place-based to take different needs into account for interventions (e.g. regional, neighbourhoods). In Rotterdam, large-scale (e.g. Maasvlakte stormsurge barrier) and small-scale flood protection measures (e.g. blue-green corridors) complement each other. Informants value green infrastructure as a cost-effective way to manage stormwater while contributing to social-ecological value (Frantzeskaki and Tillie, 2014; McPhearson et al., 2014).

While the local governments, in particular the Climate Office in Rotterdam and ORR in NYC, are the main actors responsible for ensuring and overseeing climate-proofing safeguarding measures, they establish and collaborate with diverse networks and partnerships to enable cross-boundary and cross-sectoral implementation. In both cities water and flood safety are shared responsibilities across national, regional and local governmental bodies, which requires coordination and collaboration. In NYC, effective flood-zoning policies and building codes require cooperation among the Federal Emergency Management Agency (FEMA), DOB and the Planning Department. Community engagement and participatory planning processes are increasingly employed to access local knowledge, gain support and foster resilient neighbourhoods. The Rotterdam Resilience Strategy has identified community initiatives that could be connected to the city's resilience efforts (Lodder et al., 2016). In NYC, DPR engages communities in maintaining the city's green, for example through the GreenThumb programme (Campbell et al., 2016; NYC Parks, 2016).

In both cities, stewarding capacity is constrained by an unclear distribution of responsibilities and a lack of mainstreaming of integrated and long-term risk management approaches. The former results conflicts of interests and limited financing opportunities. In Rotterdam, regional water boards collect taxes for water safety, but they are by national law not allowed to invest in flood defence in unembanked areas, such as the low-income South District. The lack of mainstreaming results in contradictory rules and investments that often disincentivize long-term and co-beneficial safeguarding measures. The US National Flood Insurance Program restrains some building adaptation options (e.g. elevation) by demanding to (re-)build ‘in kind’.

4.2. Unlocking capacity in Rotterdam and NYC

Unlocking capacity determines what and how drivers of unsustainability and path-dependencies are recognised and reduced. Unlocking capacity in Rotterdam and NYC is manifest in the identification of and awareness raising on drivers of emissions in connection with drivers of air and noise pollution, waste and inequality, and the creation of new incentives and regulations to control unsustainable practices and support alternatives.

In both cities, informants found that the revelation of drivers of emissions and relationships with other vulnerabilities and unsustainabilities was critical to identify target areas for action and synergies between different issue areas and to generate political and societal support. Roadmaps and transition pathways help to explore different options on how to reduce emissions, for example from the port in Rotterdam (Samadi et al. 2016) or buildings in NYC (NYC, 2015b). In NYC, the city government mandates reporting mechanisms to collect data. For example, the Greener Greater Buildings Plan (GGBP) (NYC, 2009) mandates owners of buildings over 50.000 ft^2 to annually disclose their energy and water consumption and identify target areas for policies and cost-effective upgrades. There is also a high level of institutional capacity for departments like the NYC Department of Health and Mental Health' (Health Department) to collect data.

Incentives, regulations and procurement standards promote investments in renewable energy production, energy efficiency in buildings and sustainable transport. The NYC government adopted legislative changes like the GGBP to change building regulations. The Rotterdam government supports the development of new business cases, for example involving privileges and funding constructions for electric freight transport and retrofitting. To achieve changes in incentive structures and regulations, actors from the climate and sustainability offices lobby for political and societal support and proactively communicate the co-benefits of individual measures. The Health Department's data on the

health benefits of reducing air pollution substantiated DEP's push to regulate the phase-out of high sulphur heating oil, which also reduced emissions. Likewise, it was highlighted that the involvement of key actor groups (e.g. large homeowner associations) in the NYC Green Codes Task Force to make recommendations for the building and construction code changes was critical for the buy-in to the GGBP.

The main challenge for unlocking capacity in Rotterdam and NYC relates to a lack of mainstreaming and prioritising of sustainability and climate concerns. Existing interests, incentive structures and regulations favour short-term economic interests and investments. For example, any action towards sustainable energy in the port of Rotterdam premise the unabated continuation of industrial activities. This impedes measures that decisively challenge existing economic structures, interests and behaviour – business cases for sustainable energy investments remain thin and unappealing because of complex regulations, permit requirements and the need for technical expertise. The block of congestion charges for entering the core of Manhattan by the New York State government indicates the need for collaboration between city and state agencies with overlapping jurisdictions.

Another key challenge in both cities is to reach out to more heterogeneous populations, for example to buildings that have different types of ownerships and energy structures. In Rotterdam, the local energy cooperative Blijstrom supports the Sustainability Office by providing assistance to citizens that want to retrofit their private homes. In NYC, MOS established the Retrofit Accelerator to offer free advisory services on energy efficiency improvements.

4.3. Transformative capacity in Rotterdam and NYC

Transformative capacity influences what type of new innovations are developed and how they are embedded into structures, cultures and practices. Transformative capacity in Rotterdam and NYC is evident in the multiple strategic, operational, institutional and organisational innovations in how climate mitigation and adaptation are addressed. Strategic goals and agendas were redefined to position climate mitigation and adaptation as opportunity for sustainable and resilience and innovative, multifunctional solutions were implemented. The integrated goals were embedded in new cross-sectoral governance structures to coordinate multi-actor implementation.

The initiative and high-level political support from the Mayors and, in NYC, also from individual departments' Commissioners were critical for putting strategic and operational innovations for climate change, sustainability and resilience on the political and public agenda. Policy entrepreneurs were able to use opportunities for change – like the International Architecture Biennale in Rotterdam and Hurricane Sandy in NYC – to develop climate adaptation and resilience plans.

The creation of informal spaces, in which small and heterogeneous actor groups come together to share ideas and resources in open and collaborative innovation learning processes, has been critical to enable out-of-the-box thinking and ensure flexibility in navigating existing regulations. In Rotterdam, the Floating Pavilion Partnership brought together actors from knowledge institutes, the local government, private companies and local communities to create knowledge on floating developments and implement the Floating Pavilion pilot project. The RbD-competition, which was initiated by HUD after Hurricane Sandy and resulted in three resilience projects in NYC, demanded far-reaching expert and community engagement to ensure local support and relevance. The involvement of diverse actors enables resource synergies, but also requires interest mediation and time. The implementation of a first water square in Rotterdam failed because there was no community support; the Benthemplein square is successfully used as a community square because local groups co-designed it.

The strategic and operational innovations were embedded into new governance structures and operational processes to enable wider uptake, replication and scaling. The cross-departmental Climate Adaptation and Sustainability Offices in Rotterdam and MOS and ORR in NYC were established to embed the integrated thinking on strategic goals into organisational processes within the respective city governments. Institutionalised partnerships like the RDM Campus in Rotterdam continue the development of innovations like floating constructions. The strategic goals were operationalised into or connected to action programmes on specific topics, such as the NYC Cool Neighbourhoods programme (NYC, 2017) and the redevelopment of the old city ports area in Rotterdam (Frantzeskaki et al., 2014). Vice versa, the experimentation with innovative solutions resulted in proof-of-concept lessons. Other water squares were implemented in Rotterdam taking on board lessons to reduce technical complexity. The architecture firm De Urbanisten that implemented the Benthemplein water square builds on the water retention function covered by the square to develop a climate-proof city quarter, the Zomerhofkwartier, in the area.

Despite these successes in innovating climate governance approaches, strategies and solutions in Rotterdam and NYC, these do not yet permeate city-wide planning and decision-making. In Rotterdam, innovative projects often remain stand-alone initiatives, which are showcased internationally, rather than locally, to create business opportunities for local companies (Hölscher et al., 2018b). Learning from experiments remains largely ad-hoc due to time constrains. While first-time innovations can benefit from lifted regulations and financial support, upscaling and replication are more constrained by existing regulations and short-term cost-benefit-calculations. In moving towards the implementation phase of the RbD-projects in NYC, the project teams were confronted with complex regulatory barriers and competing interests of multiple public agencies and private stakeholders.

4.4. Orchestrating capacity in Rotterdam and NYC

Orchestrating capacity creates synergies between climate governance and other policy sectors across scales in line with overarching visions for sustainability and resilience. Orchestrating capacity in Rotterdam and NYC is evident in the city-wide long-term and integrated climate, sustainability and resilience goals and the formal and informal conditions and processes that were established to streamline and coordinate the activities of multiple actors and networks so they contribute towards these goals across sectors and scales.

The city-wide strategic agendas on climate change, sustainability and resilience in Rotterdam (e.g. Gemeente Rotterdam, 2015, 2016) and NYC (e.g. NYC, 2007; 2015a,b) provide overarching orientations for integrating climate priorities in sectoral policies and for designing co-beneficial climate solutions. The discussions on how to integrate different priorities also reveals trade-offs, like in NYC between restricting air conditioning to reduce emissions and the vulnerability of low-income populations, who have neither access to air conditioning nor green space, against heat waves.

The co-creative agenda setting processes create opportunities for cross-sectoral and cross-scale collaboration in project development and implementation. In NYC, the strategy development processes resulted in the establishment of formal and permanent cross-departmental, public-private task forces on specific themes like built environment and climate adaptation to align priorities, develop agendas and implement solutions. The collaboration of DPR and DOB in the Urban Heat Island group resulted in the requirement to plant street trees as part of building development.

New governance structures were created within both city governments to coordinate the implementation of the strategic agendas and ensure that climate priorities are considered. The city's sustainability and resilience offices are central nodes for overseeing, initiating and drafting the strategies and their implementation. They channel information and knowledge, establish connections with on-going processes, motivate action, search for funding and lobby for support. They also participate in cross-scale partnerships and networks to align goals and mediate knowledge and resources across local, regional and national levels. In both cities, the 100RC programme funds the formal

position of a Chief Resilience Officer that is tasked with establishing a comprehensive resilience vision for minimising the impact of unforeseen events, work across departments and with the local communities. In NYC, different departments take the lead in coordinating cross-sectoral and cross-scale action on specific topics: For example, EMD coordinates NYC's disaster and emergency planning and response operations. In Rotterdam, each Climate Office's member is placed in different city departments to ensure the office's agenda is taken up in each department's initiatives.

Private organisations and knowledge partnerships support alignment and mediation processes in Rotterdam and NYC by facilitating open spaces for knowledge sharing, reflection and idea collection. In NYC, the Harbour Estuary Program is a federally authorised programme that brings together federal, state and local agencies and citizen groups to define common goals and priorities for action around the management of the New York-New Jersey harbour and estuary. Many partnerships involve knowledge institutes; they act as the moderating actor facilitating knowledge sharing, trust building and community engagement. The SRI@JB in NYC mediates scientific and community knowledge between universities, local communities and public agencies by creating an informal space to share ideas and concerns, doing transdisciplinary research and introducing research results into the discussion.

Strategic visioning and alignment, partnership-building and mediation of knowledge and resources are time and resource-intensive. Despite the increasing diversity of networks, spaces and channels to coordinate and integrate systemic climate action in Rotterdam and NYC, these do not extend beyond a still relatively small group of key actors. As a result, in most governance practice climate mitigation and adaptation are still considered as 'doing something extra'. The absence of formal conditions for collaborative financing in line with the long-term and systemic goals makes the goals vulnerable to shifting priorities and hinders piggy-backing.

5. Discussion: lessons for transformative climate governance in cities

We sought to understand whether and how new capacities for transformative climate governance are developed as cities like Rotterdam and NYC experiment with urban climate governance. In Rotterdam and NYC, an integrated, experimental and inclusive approach to climate governance is emerging, which crosses multiple policy sectors and domains (e.g. transport, energy, health, justice), involves a variety of actors and facilitates innovative solutions. This has helped to move beyond single climate innovation programmes or solutions for responding to climate risks and uncertainty and phasing-out high-emission and unsustainable path-dependencies.

Our premise was that transformative climate governance needs to create conditions for developing integrated and systemic climate mitigation and adaptation policies and interventions that respond to and shape urban transformation dynamics and contribute to sustainability and resilience in the long-term. The analysis of the different types of governance capacities show that diverse institutional, knowledge, network and social conditions were created in both cities to systemically address mitigation and adaptation in policy and planning (Table 3). The orchestrating capacity that was developed in both cities underpins the transformative approaches to stewarding from uncertainty and risk, unlocking unsustainable path-dependencies and transforming for innovative solutions and approaches. The reframing of climate mitigation and adaptation as opportunity for sustainability and resilience has given way to putting in place institutional conditions for a systemic and long-term orientation for climate risk management and planning and experimentation with multi-functional solutions within broader goals for wellbeing and liveability in the cities. For example, the integrated perspective on climate, sustainability and resilience was embedded in context-sensitive, problem-based and community-based approaches to manage risks and vulnerabilities. The integrated perspective on climate change, sustainability and resilience also facilitates the generation of systemic knowledge on risks and drivers of unsustainability and path-dependency. For example, in NYC the connection of climate mitigation and air pollution has supported the phase-out of sulphur heating oil. Each capacity manifests in diverse network conditions that enable collaboration across scales and sectors in polycentric partnerships. The orchestration of these networks through connection nodes and intermediary spaces like the climate and sustainability offices for knowledge sharing and trust building supports ensures alignment and knowledge sharing between these partnerships and monitors action in line with the strategic vision.

However, Rotterdam and NYC are currently confronted with moving beyond the initial momentum for integrated and experimental approaches to climate governance. The capacity gaps in Rotterdam and NYC signify a lack of mainstreaming and prioritising climate-related concerns in city-wide policy and planning processes. The majority of existing incentive structures and regulations still favour short-term economic interests and investments, pre-empting co-beneficial protection from long-term risks and decisive phase-out of the root causes of emissions and sustainability. This perpetuates counteracting investments (e.g. building developments in flood-prone areas) and undermines the contribution of innovative solutions into the policy mix as they remain disconnected from mainstream policy and planning. Additionally, mitigation and adaptation actions are still often technocratic and do not account for long-term uncertainty and behavioural change. This resonates challenges in other cities: While people are typically targeted through information, training and incentives, this is not able to achieve social change in for example energy, use, eating or transport patterns (Moloney and Horne, 2015). The incorporation of the level of acceptable risk in planning (e.g. 1-in-100 year flood level) and the upgrade of zoning regulations are often insufficient for dealing with projected future climate change and can lock communities in maladaptive pathways (Torabi et al., 2018).

The next-step challenge in Rotterdam and NYC is to move beyond the initial conditions created by the formulation of a long-term and systemic strategic agenda, setting up partnerships and coalitions and the experimentation with innovative solutions. The governance capacities have mainly been created through informal governance processes like envisioning, experimentation, coalition building and learning. These have contributed to momentum for systemic, long-term, multi-actor and learning-based climate governance approaches. However, there is a need for strengthening institutional and organisational conditions for more decisive prioritisation of long-term climate investments and actions, better funded collaboration mechanisms and improved space for (learning from) experimentation. This resonates findings on polycentric urban climate governance, which highlight the need for balancing monocentric, centralised and polycentric, decentralised forces (Pahl-Wostl and Knieper, 2014; Gordon and Johnson, 2017). Despite the current discourse on a state hollowed out by austerity and captured by neoliberal forces, these conclusions highlight the critical role of governmental actors in coordinating, motivating and mandating climate action at multiple scales (Frantzeskaki et al., 2014; Capano et al. 2015). For example, states shape polycentric governance and voluntary private commitments at local levels in both passive and active ways, including the implementation of policy instruments, mainstreaming climate change into policy sectors, facilitating diffusion of governance innovation and encouraging learning by establishing bodies with evaluative capacities (Jordan et al., 2018; Hodson et al., 2018).

We highlight three challenges for strengthening institutional and organisational conditions underpinning capacities for transformative climate governance in cities by moving beyond envisioning, beyond coalitions of the willing and beyond experimentation.

Table 3
Transformative climate governance capacities (conditions and activities) in Rotterdam and NYC.

Capacity conditions		Activities
Stewarding capacity		
Generating knowledge about system dynamics	Knowledge condition: *Long-term, systemic and context-specific knowledge about risks and uncertainties*	Long-term forecasting of systemic risks and uncertainties across scales Generating problem-based and context-specific knowledge in vulnerability hot spots Identifying and prioritising high-risk areas for directing investments
	Network condition: *Knowledge partnerships*	Creating issue-specific and multi-stakeholder research programmes and partnerships for knowledge generation across scales and sectors Formalising research partnerships and networks
	Institutional condition: *Knowledge mandates*	Mandating knowledge generation to ensure access to data
Strengthening self-organisation for stewarding	Institutional condition: *Flexible, problem-based and fit-to-context planning and management approaches*	Integrating long-term, systemic risks and uncertainties into planning and management approaches Adopting problem-based, fit-to-context and no-regret planning and management approaches Providing flexible regulation and incentives to facilitate fit-to-context risk protection Clearly assigning and communicating responsibilities of actors
	Network condition: *Multi-scale and cross-sectoral networks and partnerships for risk planning and management*	Establishing issue-specific, multi-level and cross-sectoral collaborations to develop and implement projects in line with context needs Involving communities in joint and context-specific visioning, planning and implementation processes
	Social condition: *Social capital and actor empowerment*	Raising awareness about risks and response options Strengthening social networks to enable self-organised response and social resilience
Monitoring and continuous learning	Knowledge condition: *Institutional and social memory*	Drawing on past experience and learning about new solutions Continuously updating plans and resilience and sustainability indicators
Unlocking capacity		
Revealing unsustainable path-dependency and mal-adaptation	Knowledge condition: *Identifying and exploring systemic drivers*	Identifying systemic social and economic drivers of unsustainability and path-dependency Road mapping and scenario analyses to explore phase-out options Conducting regular emissions inventories
	Network condition: *Knowledge partnerships*	Establishing public-private knowledge partnerships to identify drivers and explore phase-out options
	Institutional condition: *Knowledge mandates*	Mandating knowledge generation to ensure access to data
Undermining vested interests and incentive structures	Institutional condition: *Support for sustainable business cases and investments*	Setting standards for sustainable investments Providing incentives for sustainable investments Integrating sustainability into public tendering
	Institutional condition: *Control of unsustainable practices*	Implementing regulation to control unsustainable practices
Breaking open resistance to change	Social condition: *Societal and political awareness and support*	Raising awareness and providing assistance for sustainable investments and behaviour change Lobbying for political support
	Network condition: *Key support networks and partnerships*	Setting up public-private partnerships for issue-specific action Setting up support networks with key stakeholders (groups)
Transformative capacity		
Enabling novelty creation	Social condition: *Leadership for creating and using opportunities for change*	Mobilising political leadership to put new and ambitious goals on the agenda Making use of momentum and opportunities for change Piggy-backing and quickly expressing potential of a new solution
	Network condition: *Multi-actor innovation networks*	Forming informal 'coalitions of the willing' for strategic and operational innovation Involving communities in design and implementation of experiments
	Institutional condition: *(Regulatory, financial) space for innovation*	Temporary lifting or avoiding existing regulations
Increasing visibility of novelty	Social condition: *(Trans-)local support for the innovation story*	Creating and advocating an inspiring innovation story Showcasing innovations as market potential for the city
	Network condition: *Advocacy coalitions*	Creating advocacy coalitions to carry the innovation story Participating in and hosting local, regional, national and international networking, best practice and knowledge exchange events for visibility
Anchoring novelty in context	Knowledge condition: *Learning for replication and upscaling*	Identifying proof-of-concept lessons from innovations to facilitate replicating and embedding Identifying opportunities from innovation for upscaling Identifying bricolage of solution elements to mainstream innovations into urban planning processes and decisions
	Network condition: *Self-sustaining innovation networks*	Formalising operational public-private partnerships for continuous innovation Setting up cross-sectoral networks and partnerships tasked with (embedding of) innovation in institutional structures
	Institutional condition: *Institutional space for embedding strategic and operational innovations in mainstream practice*	Creating open mind-set for taking up innovations in tactical agendas and daily practices Allocating budget to developing and maintaining innovation, upscaling and replicating
Orchestrating capacity		

(*continued on next page*)

Table 3 (*continued*)

Capacity conditions		Activities
Strategic alignment	Institutional condition: *Long-term and integrated goals*	Developing long-term climate mitigation and adaptation, sustainability and resilience goals
	Social condition: *Involvement of multiple actors in shared strategy formulation and visioning*	Involving multiple actors from different city departments and private organisations in strategy formulation Public outreaching and participation
Mediation across scales and sectors	Network condition: *Connection nodes for pooling climate action*	Establishing central connection nodes for pooling climate efforts at multiple levels Establishing cross-departmental city offices for coordinating and knowledge brokering at multiple levels Designating theme-leads and contact persons within individual departments Identifying private and community-based activities to seek linkages
	Network condition: *Intermediary spaces for knowledge sharing and trust building*	Creating neutral co-creation spaces and knowledge partnerships to build trust for knowledge sharing and resource synergies across scales and sectors Participating in international city networks Establishing cross-departmental co-creation spaces for knowledge exchange, priority alignment and trust building
	Knowledge condition: *Pooling and integrating knowledge and resources across scales and sectors*	Identifying opportunities, synergies and trade-offs between different goals
Creating opportunity contexts	Institutional condition: *Framework conditions and financing mechanisms for long-term co-benefits*	Redefining responsibilities for carrying costs Creating competitions to leverage innovative, long-term and co-beneficial solutions

5.1. Beyond envisioning

Long-term and systemic visions provide a shared orientation for aligning priorities, motivating actors and designing co-beneficial climate solutions while taking the interests of multiple, including most vulnerable actors into account (Nevens et al., 2013; McPhearson et al., 2017; Shaw et al., 2014). However, this strategic orientation remains relatively meaningless to the policy and planning practices in individual policy sectors when it is not consistently and decisively translated into institutional frameworks and financing mechanisms that change incentive structures and organisational ways of working (den Exter et al., 2014; Wamsler, 2015). While the strategic agendas in Rotterdam and NYC were translated into theme-specific action programmes, these programmes and regulations still remain patches within overall city policy and planning processes, which still perceive efforts to implement the strategic agenda as doing something extra. Systemic financing frameworks such as enabled by the Rebuild by Design competition helped to develop multi-beneficial projects in NYC, yet as long as business-as-usual is (financially) viable sustainable business models remain thin and climate-proofing is perceived as more expensive. This makes the strategic agenda vulnerable to changing political priorities and economic interests and perpetuates counteractive investments (Torabi et al., 2018; Rosenzweig et al., 2015).

This underscores how institutional and organisational rigidities, lack of clear mandates and conflicting political priorities are key barriers to integrated and bold climate action (Keskitalo et al., 2016; Homsey and Warner, 2015). Ultimately, tough decisions about what goals are to be priorities need to be made and mainstreamed into institutional frameworks at multiple levels of governance (Moloney and Horne, 2015). Although urban climate governance has proliferated despite an absence of leadership at national levels (Bulkeley and Betsill, 2013), the nestedness of local climate governance in legal and institutional framework at regional, national and international levels requires alignment of priorities and legislation across governance levels (Dąbrowski, 2017; Keskitalo et al., 2016). While in both Rotterdam and NYC regional and national governments support climate governance through research programmes, regulatory frameworks and incentives, national and regional policy frameworks in the Netherlands and the US often constrain long-term climate adaptation and sustainability investments. However, also positive examples of state regulation promoting urban climate governance actions abound. The Clean Air Act, which was passed in the US in 1970 and strengthened in 1990, enabled federal and state authorities to establish comprehensive regulations for air pollutants and reduced ground level ozone and lead air pollution in cities (Ross et al., 2012).

5.2. Beyond coalitions of the willing

In Rotterdam and NYC, a diversity of cross-sectoral, cross-scale and public-private partnerships and networks, including regional and national knowledge programmes, research partnerships, research-industry collaborations and private stakeholder platforms, participate in the generation of knowledge, the formulation of strategies and agendas and the development of innovative solutions. While the increasingly self-organising ways of delivering societal functions have spurred scientific and policy attention to bottom-up and decentralised governance modes, urban climate governance scholars find that coordination is required to accompany decentralised and hybrid climate governance implementation to enhance cooperation between city departments and across governance scales, start initiatives when needed, pool knowledge, information and guidance, and pool monitoring (den Exter et al., 2014; Pahl-Wostl and Knieper, 2014).

In Rotterdam and NYC, the local governments take up key roles in coordinating climate action, having set up formal and informal cross-boundary coordination structures such as the cross-departmental resilience and sustainability offices to align, motivate and support climate action across scales and sectors in line with the strategic visions. Being positioned at the centre of horizontal and vertical integration local governments can ensure compatibility and coherence, act as primary organiser of dialogue among policy communities, deploy a monopoly of organisational intelligence and information and balance power differentials (Frantzeskaki et al., 2014; Amundsen et al., 2018). Enabling local governments to do so requires however a new type of organisational capacity to mediate between priorities across scales and sectors and the context of their application, assign action mandates and oversee progress (den Exter et al., 2014). While the coordination processes in Rotterdam and NYC facilitate trust building, interest mediation and cooperation, they are faced with time and resource constraints visible in the limited connection to actors and networks outside of the immediate climate and sustainability domains.

For what purpose and for whom coordination mechanisms are set up requires careful scrutiny (Gordon and Johnson, 2017). The inclusion of a wide range of societal actors is critical to take different interests into account, make complex sets of goals like resilience understandable,

ensure top-down priorities are aligned with local-level needs and tap into the multiple capacities of actors to achieve the deep structural and behavioural changes required (Brown, 2017; McPhearson et al., 2017). Strategically building alliances between local communities and local governments could be a powerful way for ensuring local knowledge and needs are accounted for and for mobilising broader societal action (Chu et al., 2017). This was illustrated in NYC, where neighbourhoods with strong community organisations, such as Redhook, benefited from their substantial support in the aftermath of Hurricane Sandy when local, state and federal agencies struggled with providing relief (Cowan and Hogan, 2014).

5.3. Beyond experimentation

Experimentation has been appraised as an open-ended way for trialling new, agile and responsive solutions to deal with the significant uncertainties and complexities of climate change and urban transformations and contribute to the radical changes necessary for achieving sustainability and resilience (Bulkeley et al., 2016; Castán Broto and Bulkeley, 2013; Karvonen, 2018). In Rotterdam and NYC, the creation of space for experimentation by lifting regulatory requirements and providing systemic financing frameworks, has allowed to test new solutions in co-creative ways. However, the experiments often remain disconnected from mainstream urban governance processes, manifesting in 'pilot paradoxes' that embody stand-alone innovations, which do not inform policy and planning (Van Buuren et al., 2018; Hölscher et al., 2018b).

The aspiration to inform and acquire new ways of problem-solving implies some sort of learning about what the tested innovations bring about in the policy mix of cities (Luederitz et al., 2017; Raven et al., 2017). Moving 'beyond experimentation' requires the dedication of time to identify, evaluate and translate lessons from specific innovations, such as about the viability, replicability and scalability, for their broader context (Turnheim et al., 2018; Ehnert et al., 2018). The institutionalisation of innovation partnerships like the RDM Campus in Rotterdam and the Rebuild by Design offices in the US help to translate lessons from experimentation and support on-going experimentation processes. However, current trends towards a 'projectification of funding', which is reinforced by governments' focus on cost-optimisation and effectiveness, does not allow moving beyond innovative initiatives (Ehnert et al., 2018). Replicating and scaling successful innovations requires the processes for knowledge mediation, for example between strategic and operational governance levels to adapt regulatory frameworks according to the lessons from innovation, identify proof-of-concept indicators and translate lessons into tactical agendas for context-specific (combinations of) solutions and to strategically connect experimentation processes to other on-going projects (Hölscher et al., 2018b).

6. Conclusions

We employ the notion of transformative climate governance in cities to epitomise the urgency and opportunity for delivering integrated and bold climate strategies and actions, which achieve the profound changes in urban systems needed to address climate change and sustainability challenges. There is a risk to give in to a somewhat naïve narrative of urban opportunities for delivering effective and transformative climate action when it is unclear how these opportunities can be harnessed in meaningful and just ways and over longer time frames. By comparing the capacities for transformative climate governance in Rotterdam and NYC we could identify institutional, knowledge, network and social conditions that were created as a result of the activities in both cities to govern climate change and that help moving towards integrated, experimental, reflexive and inclusive climate mitigation and adaptation approaches.

Envisioning, long-term goal and knowledge integration, experimentation and tapping into coalitions for change help to provide the basis (including guiding principles, urgency, actor networks, innovative solutions) for transformative climate governance. However, in both cities inclusive, integrated and experimental climate governance approaches tend to be still subordinate to business-as-usual interests and policy and planning approaches, which favour isolated, incremental and short-term responses. The challenge for strengthening transformative climate governance that crosses policy siloes and is able to deal with stranded assets, difficult choices and phasing-out established interests and practices will be to develop rigorous institutional and organisational conditions that decisively stipulate a prioritisation of climate change across scales and sectors, provide action mandates and enable wider outreach and learning.

There remains a tension between top-down law-enforcement on the one hand and the need to facilitate open-ended, experimental and flexible governance processes in the face of uncertainty. Likewise, top-down rule-making does not mean that it should not be based on knowledge co-production and deliberation between actors with different kinds of technical or contextual expertise. Applying the lens of governance capacities highlights the emergent character of how urban governance is enacted in a dynamic and provisional way: The mobile character of governance capacity characterises the creation of governance capacity as a learning process. Governance capacity thus becomes an "action-oriented and empowering concept", which helps "to identify requirements, design policies and devise purposive interventions" (Wolfram et al., 2017: 24).

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Abbreviations

100RC	100 Resilient Cities
DCAS	NYC Department of Citywide Administrative Services
DEP	NYC Department of Environmental Protection
DOB	NYC Department of Buildings
DOT	NYC Department of Transport
DPR	NYC Parks and Recreation Department
EDC	NYC Economic Development Corporation
EMD	NYC Emergency Management Department
FEMA	US Federal Emergency Management Agency
GGBP	Greener Greater Buildings Plan
HPD	NYC Housing Preservation Department
HUD	US Federal Department of Housing and Urban Development
MOS	NYC Mayor's Office of Sustainability
NPCC	NYC Panel on Climate Change
NYSERDA	New York State Energy Research and Development Authority
OneNYC	One New York: The Plan for a Strong and Just City
ORR	NYC Mayor's Office of Recovery and Resiliency
RbD	Rebuild by Design
RCI	Rotterdam Climate Initiative
SIRR	NYC Special Initiative for Rebuilding and Resiliency (SIRR)

SRI@JB Science and Resilience Institute at Jamaica Bay

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvman.2018.10.043.

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